

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

07/2004



CONCEPTUAL DESIGN OF OXYGEN-BASED PC BOILER

Background

Because of growing concern that a link exists between global climatic change and emission of greenhouse gases, such as CO₂, it is prudent to develop new coal combustion technologies to meet future emissions standards, should it become necessary to limit CO₂ emissions to the atmosphere. New technology is needed to ensure that the U.S. can continue to generate power from its abundant domestic coal resources. This project will design an optimized combustion furnace to produce a low-cost, high-efficiency power plant that supports the U.S. Department of Energy's (DOE) goal of developing advanced combustion systems that have the potential to control CO₂ through an integrated power system that produces a concentrated CO₂ stream for subsequent use or sequestration. Specifically, this work will evaluate the technical viability and economic competitiveness of an oxygen-enriched, pulverized coal (PC) fired boiler system with CO₂ sequestration. When oxygen is used in place of air as the combustion medium, the flue gas has a high concentration of CO₂, making recovery of CO₂ for sequestration much more economic.

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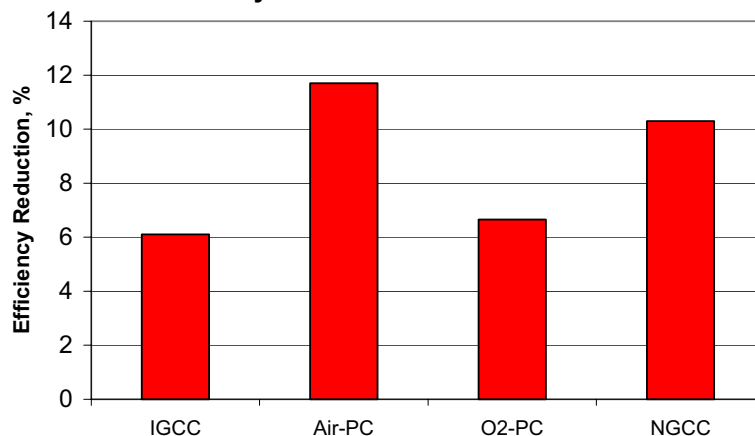
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Primary Project Goal

The primary goal of this project is to develop a conceptual PC-fired power plant, using oxygen as the combustion medium to facilitate the capture of CO₂ for subsequent sequestration.

Efficiency Reduction Due to CO₂ Removal



CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

PARTNERS

Foster Wheeler
Development Corporation

COST

Total Project Value
\$406,482

DOE/Non-DOE Share
\$325,186/\$81,296

Objectives

- Conduct a literature review to evaluate previous work in this area.
- Develop process modeling simulations for a conceptual design for an oxygen-enriched, PC-fired boiler with CO₂ capture.
- Develop a conceptual power plant design.
- Estimate costs for this conceptual power plant.
- Predict power plant performance and emissions and compare the overall cost of electricity of the conceptual power plant to a conventional PC-fired power plant (460 MWe subcritical, natural circulation boiler firing high-volatile bituminous coal to produce 2,400 psig steam at 1,050°F and reheat steam at 1,050°F).

Accomplishments

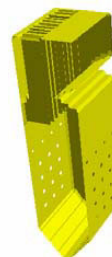
The entire cycle has been modeled in Aspen-Plus, including mills, air heater, furnace, heat recovery banks, feed water heaters, and steam turbines. Parametric runs have been made to evaluate the effect of operating variables on furnace performance. These studies have led to several conclusions. A higher flame temperature results in a more compact furnace and less gas recycle (limited by maximum furnace wall temperature) and to a higher cycle efficiency due to greater boiler efficiency. Estimates indicate that the parasitic power requirement for CO₂ capture is considerably lower than for a conventional plant and is comparable to that for an integrated gasification combined cycle (IGCC) system. Similarly, efficiency loss due to CO₂ capture is lower than for a conventional plant and comparable to an IGCC system.

Benefits

This project is evaluating a potential new power generating technology which could have the same efficiency and CO₂ sequestration potential as IGCC in a simpler facility. A substantially reduced furnace size leads to cost benefits, and a simple plant design means high reliability. The new plant uses proven steam plant technology. New air separation techniques could significantly improve economics.



Air-fired
furnace



O₂-Fired furnace
(50% smaller)

Spatial comparison of an air-fired furnace versus an oxygen-fired furnace.